TISICS

BSBF Conference
TISICS Overview
October 2022

TISICS is pioneering **lighter** and **greener, aircraft** and **spacecraft components** with world leading **metal composite** and **net-shape manufacture** technologies.

Rushlight *Awards*
Winner 2019/20
January 2020

Most significant advancement in forms of **transport** which result in **significantly improved environmental footprint.**

Pitch@Palace 11.0
2019 Finalist

TISICS has a unique composite technology

TISICS
Metal Composites

30% - 70% component system weight savings with TISICS composites

≈

TISICS TITANIUM COMPOSITE TUBE (36g) just over an ounce

WEIGHT OF A CRISP PACKET

WILL CARRY 5,000Kg
11,000 pounds

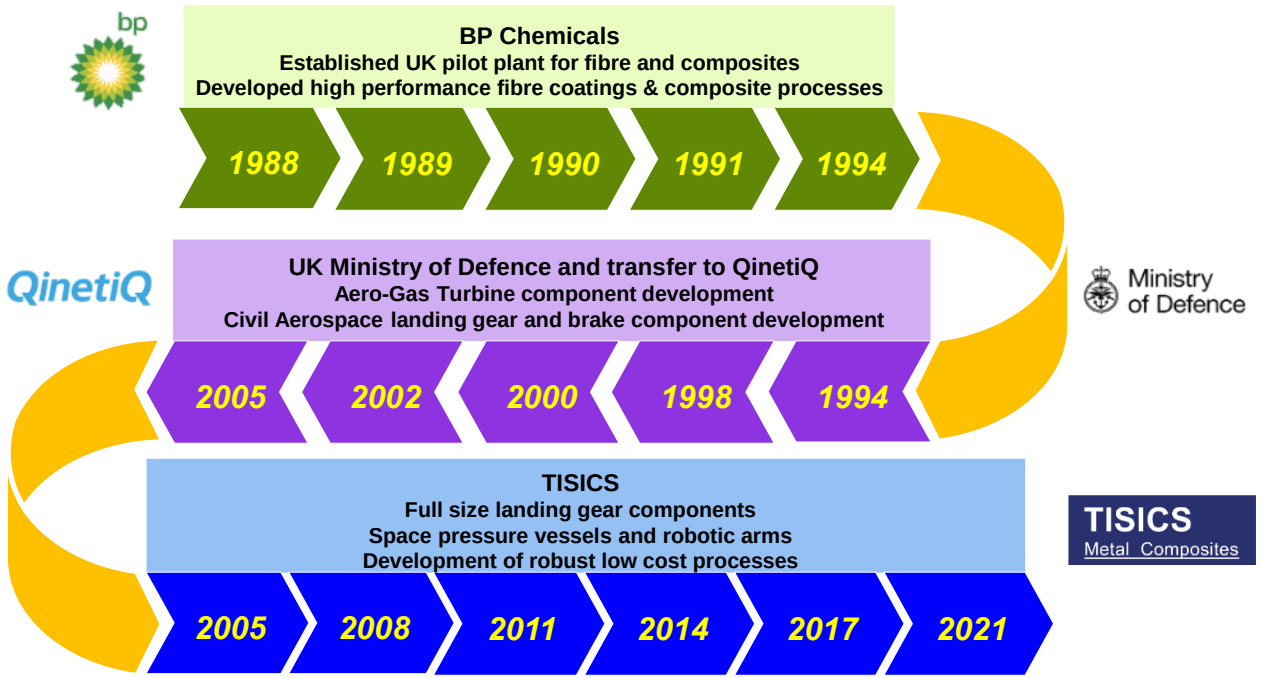
TISICS mission: ***Transform metals for a greener, brighter future***

Technology Development

TISICS
Metal Composites

Technology Heritage

TISICS and its predecessors have maintained UK independent access to silicon carbide fibre since the 1980s ensuring European access advanced light weight components without ITAR restrictions.



Technology & Capability Investment

£ 3.5m
Total capital investment since 2005

£ 7.99m
Total technology & process R&D

£ 14.m
Revenue to date

£ 1.5m
Management equity

info@tisics.co.uk @TiMetalMatrix www.tisics.co.uk

Vertically Integrated Capabilities

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Metal Composites

World unique integrated composite manufacture

- One of two commercial silicon carbide fibre suppliers worldwide
- Fibre competitor based in USA and subject to ITAR/EAR controls
- Only commercial supplier worldwide with integrated fibre and composite capability

Certifications

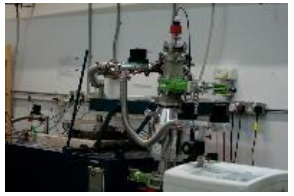
SYSTEM CERTIFICATION ISO 9001 SGS

UKAS MANAGEMENT SYSTEMS 005

MANUFACTURE

SiC Production

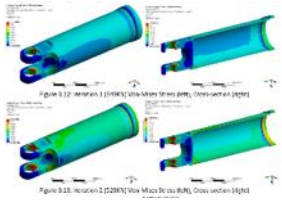
Cleanrooms



Furnaces & Vacuum Processing

CNC: Lathes, Mills, Wire Eroder

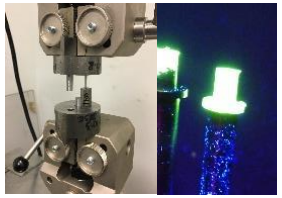
DESIGN



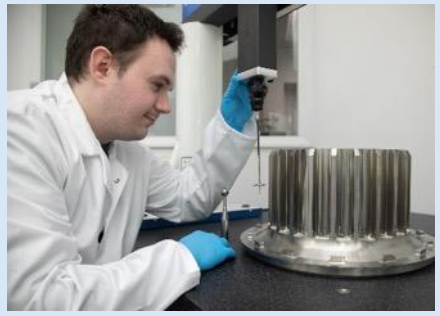
CAD, FEA

TEST

Inspection, Analysis



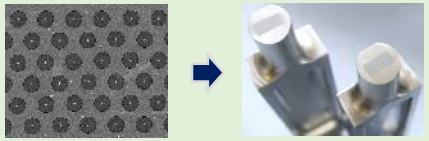
Tensile, compression, fatigue testing & NDE



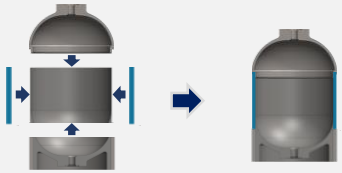
TECHNOLOGY

CERAMIC FIBRE

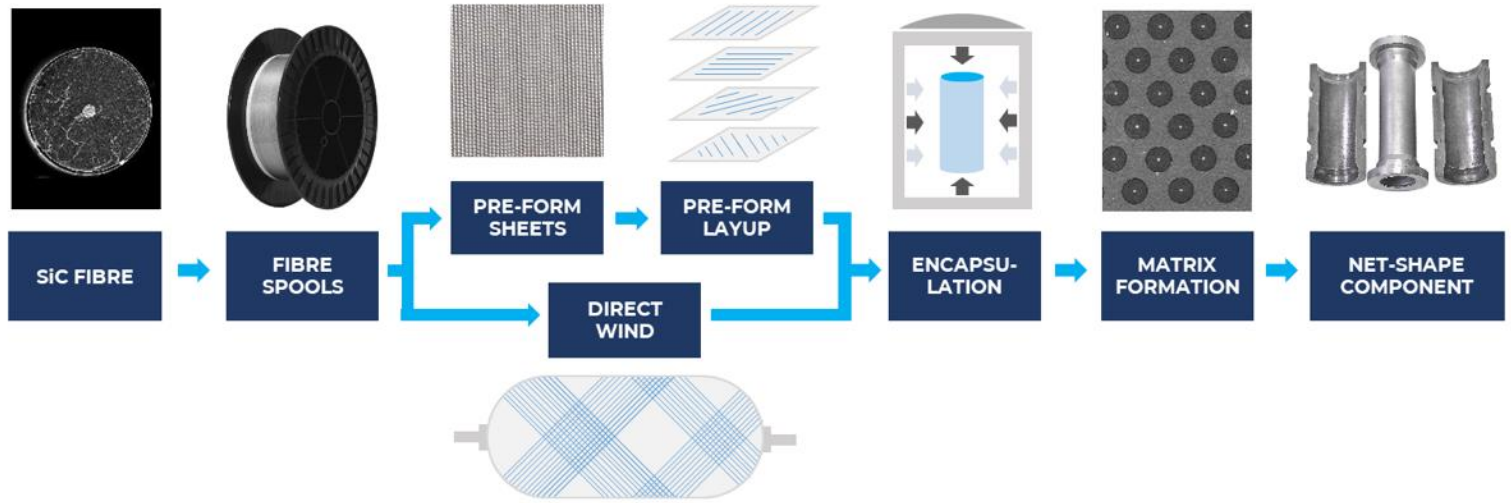
TITANIUM, ALUMINIUM COMPOSITES



NET SHAPE FABRICATION

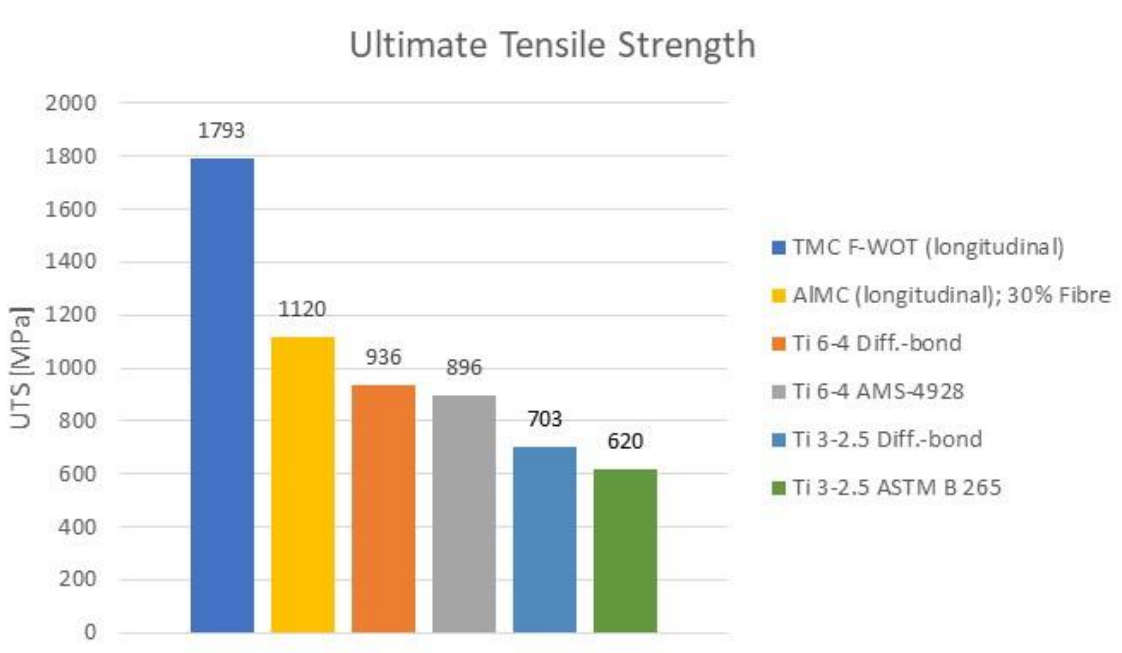


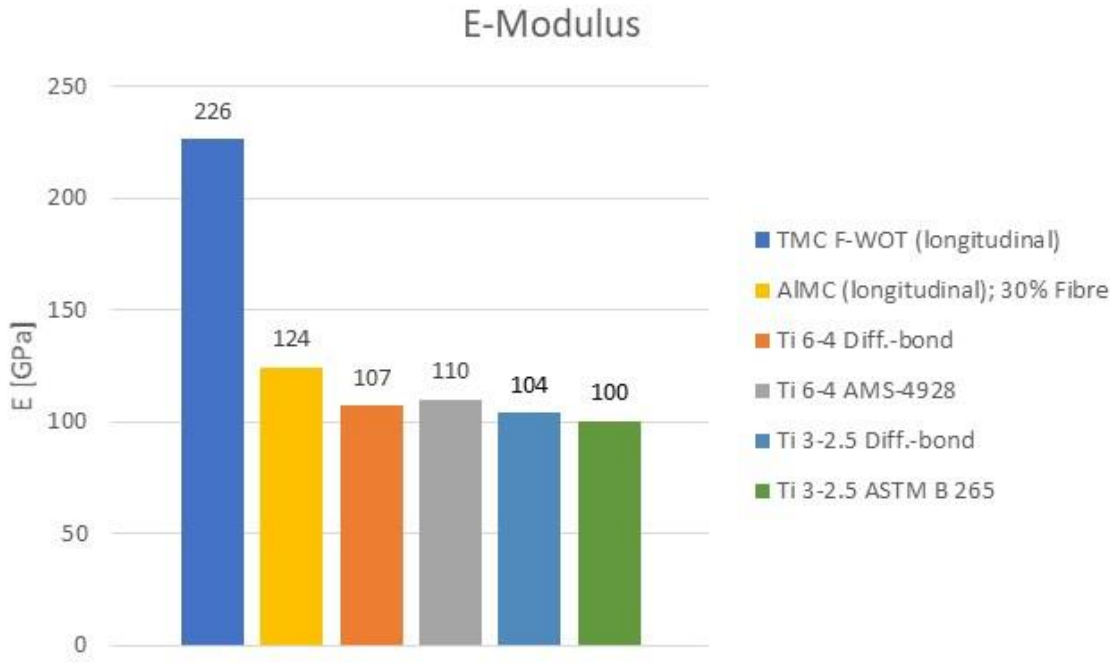
COMPOSITE MANUFACTURE



Near net-shape process minimises welding, joining and final machining

Material – Titanium and Titanium Matrix Composite

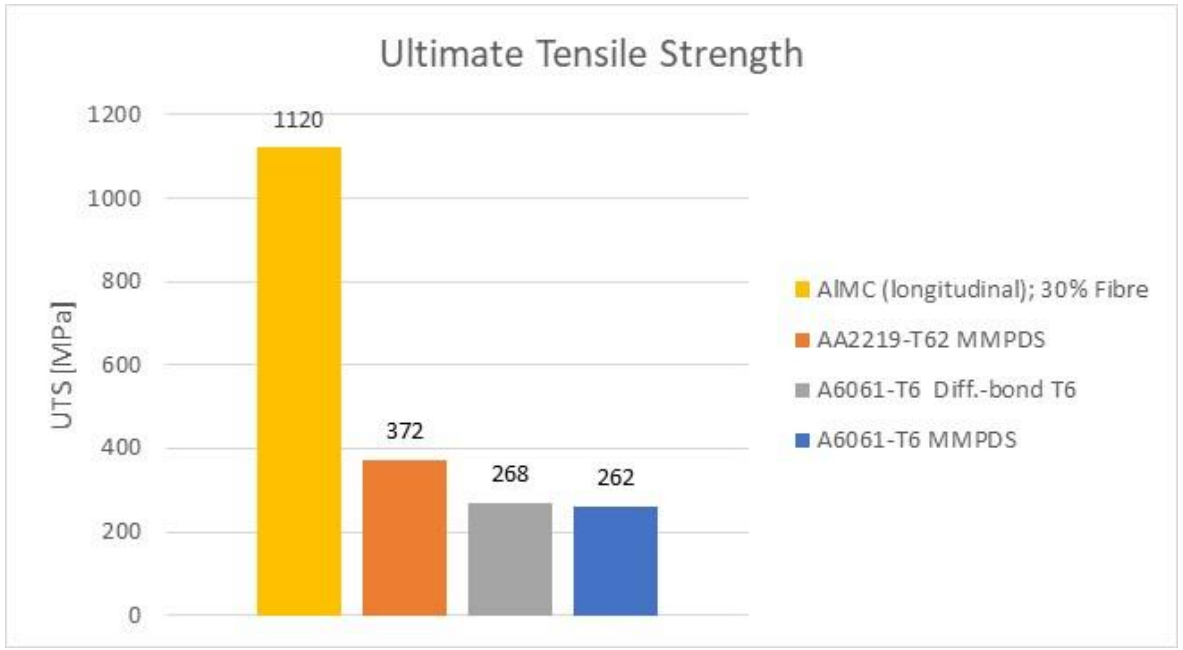


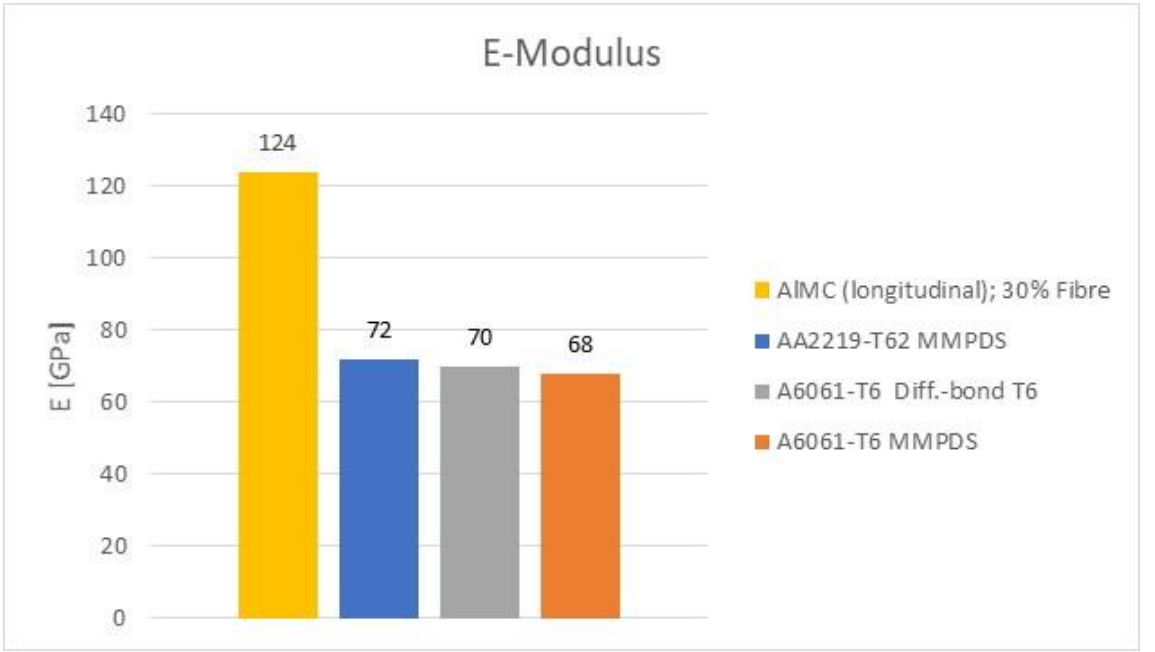


- Strength & E-modulus of TMC approx. 2x conventional titanium in longitudinal direction
- Aluminium 6061 matrix composite (AlMC) has comparable strength and higher stiffness than conventional titanium 6-4 at ~30% lower density

TISICS
Titanium Composites

Material – Aluminium and Aluminium Matrix Composite



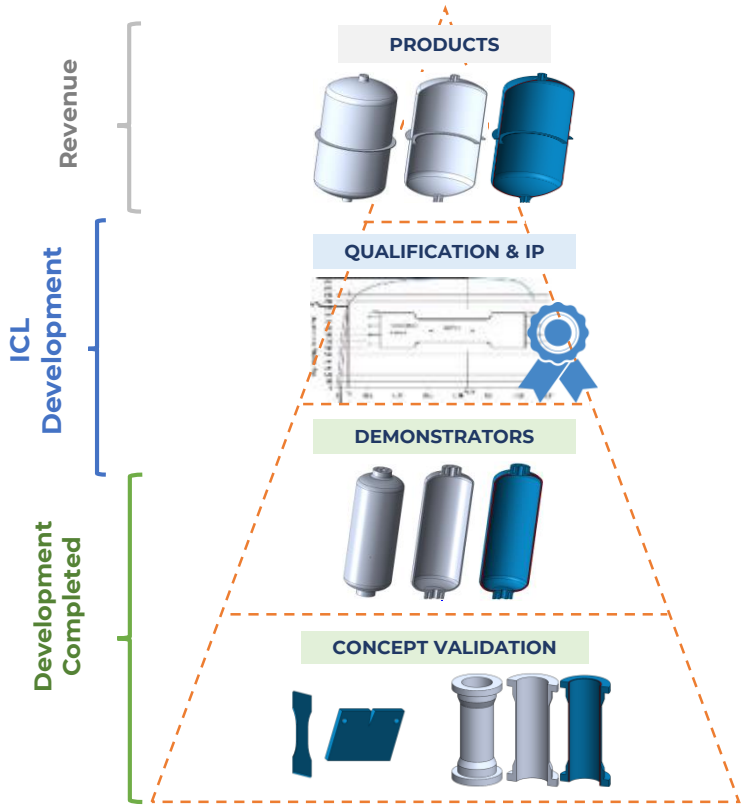


- Strength of AlMC approx. 4x conventional aluminium in longitudinal direction
- E-modulus of AlMC increased by approx. 70% compared to conventional aluminium

Pressure vessel development – Small Science to Big Science

TISICS Metal Composites

Technology and Manufacturing Readiness Timeframe



Research and Development
funded by TISICS research grants and customers

High pressure tank
2010

SURREY
Innovate UK

ITI Spherical tank
2012

SURREY
esa

NEO Sat tank
2012-2015

AIRBUS DEFENCE & SPACE
Innovate UK

Hydrogen peroxide tank
2016-2018

SURREY
Innovate UK

Twin tank
2016-2018

ThalesAlenia Space
UK SPACE AGENCY

Robotic fabrication development
2016-2020

thinklaser
AIRBUS DEFENCE & SPACE
ThalesAlenia Space
esa
UK SPACE AGENCY

Development supported by customers

Diffusion-Bonding Process – Production Steps for Net-shape Tanks and COPV Liner (General)

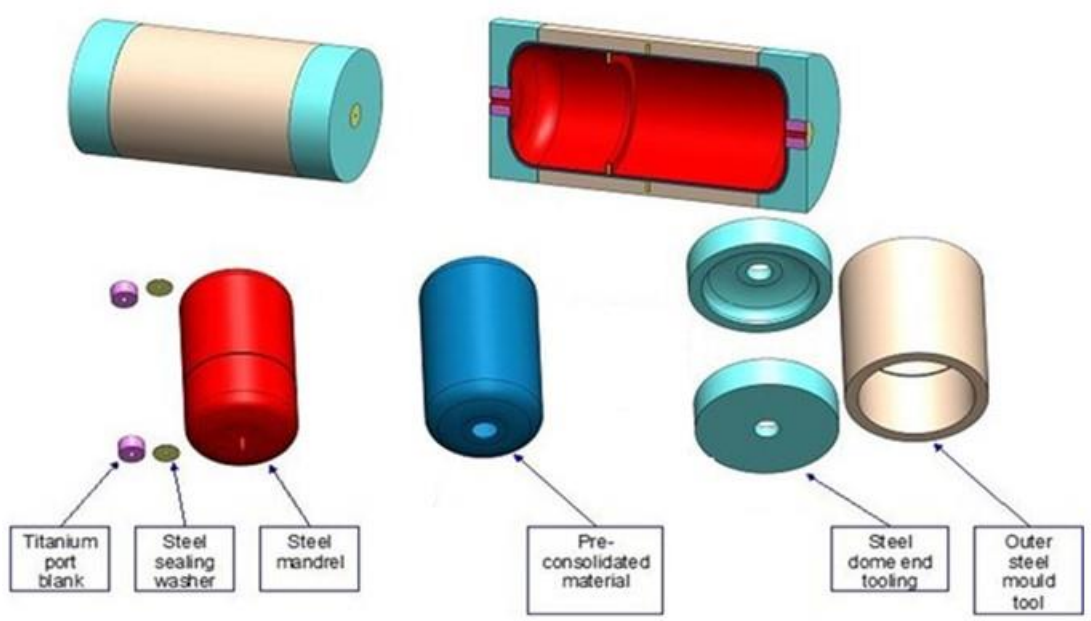
Raw material:

- Round bar (inlet/outlet), machined to required geometry
- Low cost alloy sheet or foil for hemisphere and cylindrical shells
- Low cost alloy plate/bar machined with minimal waste for attachment devices and diaphragm mounting features

Net-shape forming:

- Simple lay-up and assembly of sub-elements into final tooling
- Encapsulation to seal inner and outer tooling around tank materials
- Diffusion-bonding (Hot Isostatic Pressing, HIP)
- Mould removal to produce net-shape tank
- NDI (US-inspection) on tank assembly for structural integrity

Flexible Tooling Technology can be adapted and optimised for bespoke Variants in a Family of Tanks



Inner Tooling & Machined Port / Diaphragm Attachment

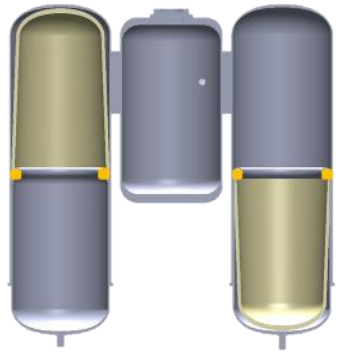
Lay-up Foils/Sheets on Inner Tool

Encapsulation with Outer Tool

Small Propellant Tank incl. Novel Diaphragm Attachment

Bespoke Tanks optimised for Volume within Geometric Constraints for a NanoSAT and CubeSat Platforms

- Combined twin chemical and pressurisation tank with integral mounting flange
- Novel propellant expulsion attachment integral to base port hemisphere
  - *Reducing assembly time and increasing reliability as no bolted attachment feature*
  - *Reducing stresses in critical clamping area*
  - *Reduced mass*
- Thin-walled tanks with diffusion-bonded weld feature
- Maximised propellant volume due to integral gas manifold (eliminates the orbital arc tube welds)
- Port configuration can be located to customer needs, e.g. side walls, etc.
- Pressure and propellant expulsion tested

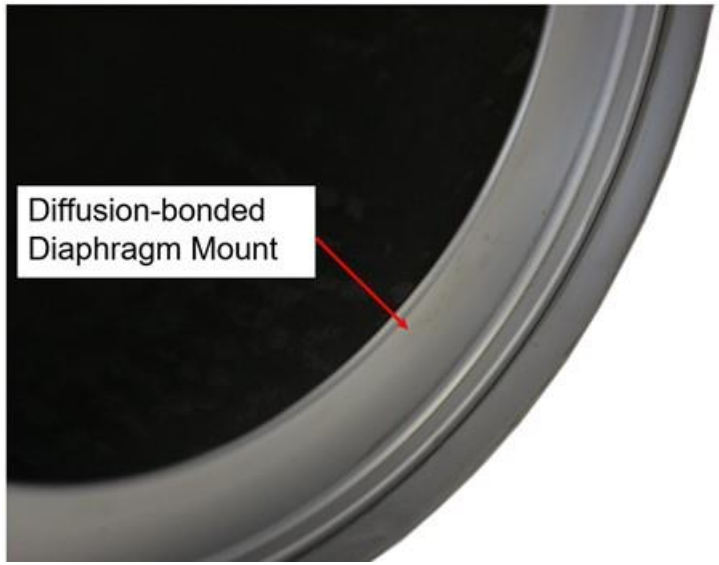


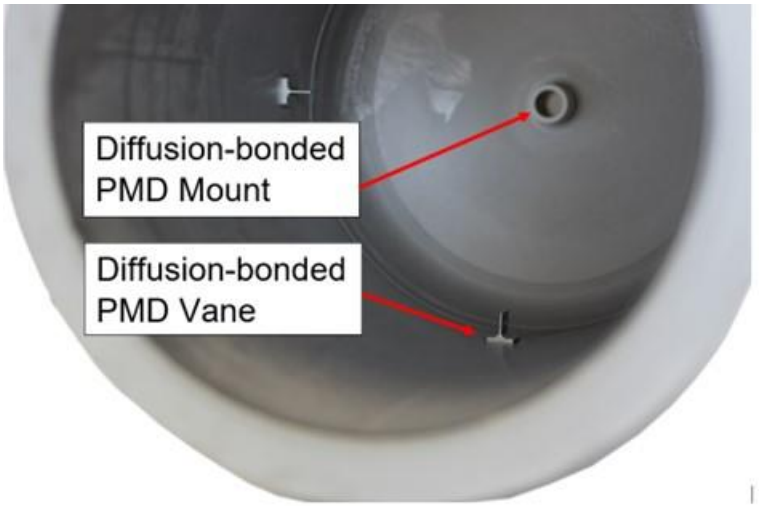
Diffusion-bonded Weld Feature

Internal and External Features

Diffusion-bonded Integral Joints and Mounting Devices:

- **Diaphragm internal attachment feature**
- External equatorial / pedestal / polar mounting devices
  - All joints and attachment features can be tailored to customer needs
- PMD & PMD vane mount
  - Integral diffusion-bonded weld feature
  - Elimination of complex EB-welds





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Titanium Composites

State-of-the Art Forging / Machining vs. Diffusion-Bonding Process

Conventional Process

Forging

Forging: Typical duration 9-12 month incl. heat treatment

Tooling: **Expensive** individual tooling required for each size of part

Facilities: Highly specialised facilities

Cost: Process suited to high volumes, typical volumes required to produce satellite tanks are low; fluctuating raw material costs have a significant impact; high cost due to high wastage of material e.g. 30-50 mm forging down to 0.6-1.0 mm shell thickness

Machining

Machining: Typical duration 3-6 month

Tooling: **Expensive** individual tooling required for each part; typically more than one piece of tooling per part; needs two sets of (vacuum) tooling to achieve thin wall thickness with required accuracy and tolerance

Facilities: Limited facilities capable of achieving high tolerance on thin-walled components; expertise is a critical aspect of producing the shell components

Disruptive Process

Diffusion-bonding

Net-shape: Typical duration **4-5 month**; significant less than forging/machining (**12-18 month**)

Tooling: **Low-cost** re-usable flexible tooling

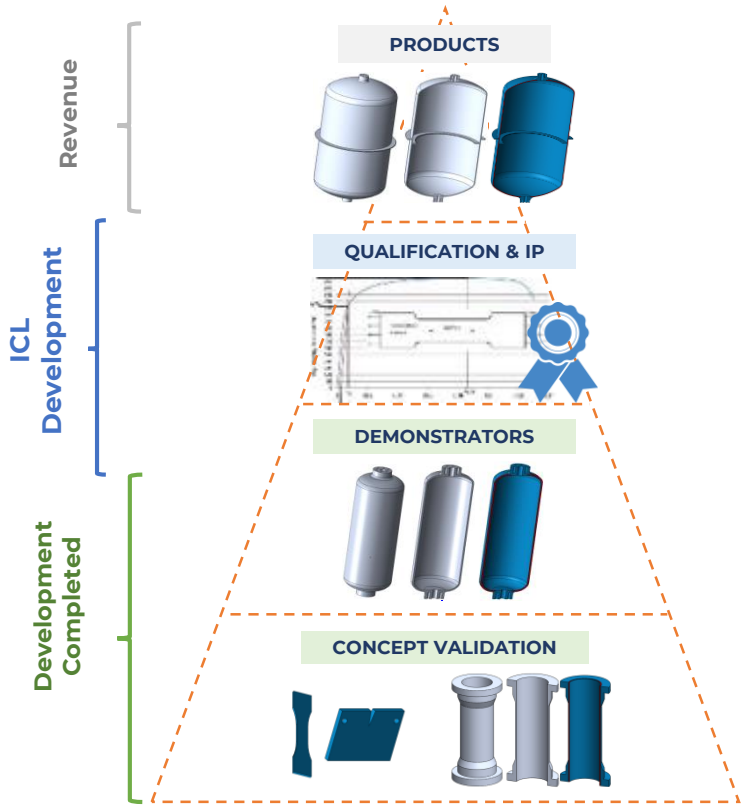
Facilities: Limited facilities

Cost: Process suited to high & low volumes, typical volumes required to produce satellite tanks are low; fluctuating raw material costs have not a significant impact as essentially no wastage of material due to net-shape forming

Pressure vessel development – Small Science to Big Science

TISICS Metal Composites

Technology and Manufacturing Readiness Timeframe



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SME – Big Science Communication

- Interaction has been extremely valuable. Perhaps the best route to adoption of new technology.
- Significant challenge in communicating problems and solutions.
- Networking is crucial and does work, but how many opportunities are missed?
- Raising awareness of technology to interested parties is a challenge as we do not know their needs and they do not know our capability.

TISICS

www.tisics.co.uk

Transforming metals for a greener, brighter future

Come talk to us

+44 (0) 1252 516678

22 Invincible Road, Farnborough, GU14 7QU, UK

Dr. Michael Rix

Senior Engineer

mrix@tisics.co.uk

Mob: +44 782 8973 962